Annual Report 2007

RAND PROJECT AIR FORCE

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RAND PROJECT AIR FORCE

About RAND Project AIR FORCE

The mission of RAND Project AIR FORCE (PAF), a division of the RAND Corporation and the Air Force's federally funded research and development center for studies and analysis, is to undertake an integrated program of objective, independent analysis on issues of enduring concern to Air Force leaders. PAF addresses far-reaching and interrelated questions: What will be the role of air and space power in the future security environment? How should the force be modernized to meet changing operational demands? What should be the size and characteristics of the workforce? How can that workforce be most effectively recruited, trained, and retained? How should sustainment, acquisition, and infrastructure be streamlined to control costs?

PAF carries out its research agenda in four programs that represent core competencies:

Strategy and Doctrine seeks to increase knowledge and understanding of geopolitical and other problems in the national security environment that affect Air Force operations. PAF maintains expertise in defense strategy; regional analysis; the objectives and tasks of evolving joint operations; and the potential contributions of air and space power to joint operations, defense planning, and requirements for force development.

Aerospace Force Development identifies and assesses ways in which technological advances and new operational concepts can improve the Air Force's ability to satisfy a range of future operational demands. This research involves assessments of technology feasibility, performance, cost, and risk. PAF assesses major force components needed in the future and the systems and infrastructure supporting their operations.

Manpower, Personnel, and Training concentrates on questions about workforce size and composition and about the best ways to recruit, train, develop, pay, promote, and retain personnel. PAF's research encompasses the total workforce: active-duty, guard, reserve, civilian, and contractor personnel.

Resource Management analyzes policies and practices in the areas of logistics and readiness; outsourcing, privatization, and contracting; the industrial base; planning, programming, and budgeting; infrastructure; and weapon-system cost estimating. The goal of this program is to maximize the efficiency and effectiveness of Air Force operations in a resource-constrained environment.

PAF also conducts research on topics that cut across all four programs, and its research staff regularly responds to Air Force requests for help on time-urgent problems.

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In Memory of Charles Robert "Bob" Roll, Jr.

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Message from the Director

For 60 years, the U.S. Air Force and RAND Project AIR FORCE have partnered to confront the nation's most pressing security challenges. From the earliest days of the Cold War, when the two institutions were created, the Air Force and RAND have collaborated to consider the strategy, forces, policy, and resources needed to protect the United States and expand U.S. influence against a variety of threats and challenges. This collaboration grew in time to encompass almost all aspects of U.S. national security, and the partnership has yielded some of the earliest and best thinking on deterrence and defense, the role of nuclear weapons in American security, establishing a secure posture for U.S. strategic forces, appropriate roles for military forces in defeating insurgents, and more. It has also produced new approaches to analysis and new ways of thinking about problems. Systems analysis and game theory are two prominent examples.

Andrew R. Hoehn

What is remarkable, looking back over this time, is the ability of the two institutions to anticipate challenges, confront hard choices, and bring new thinking to enormously difficult, seemingly intractable problems. What is even more remarkable is the ability of these institutions to grow and learn from each other. None of the successes of these earlier eras came easily, and few of them came without controversy.

Much as in earlier eras, the United States now faces a new set of security challenges that are vast in scope and that we are only beginning to understand. And much as in earlier eras, the Air Force and RAND Project AIR FORCE now need to partner to confront the most pressing challenges of our time:

- Radical Islam presents a potent threat not just in Iraq and Afghanistan but across a broad swath of Asia, Europe, and Africa. As others have noted, the challenge is not so much a clash of civilizations as a clash within a civilization, threatening not only Americans at home but also America's forces and interests and its friends and partners across the globe.

- North Korea and Iran appear to be committed to the pursuit of nuclear weapons; other nations may follow in their footsteps. In a very real sense, we could be witnessing the onset of a "second nuclear age," in which weak and strong will interact in the constant presence of nuclear weapons and with the ever-present threat that terrorists could come to possess these weapons.
- China's dramatic rise as an economic power and a potential military rival continues unabated. Each year brings new evidence of gains in China's military power, highlighting concerns regarding how this new China might wield its power and influence.
- Russia remains very much a wild card; the Putin regime, which has reaped sizable economic gains from high energy prices and a growing economy, has rolled back democratic reforms and has escalated diplomatic tensions over a range of issues involving U.S. allies and partners.

What remains in doubt is how these challenges might be connected and how quickly some of them might mature. Experience has taught us that threats can develop more quickly than we anticipate and that the pace of change can accelerate.

Given the breadth of the problems and pace of change, rigorous, creative analysis will be needed to provide a sound basis for the many choices the Air Force leadership will make in the years to come. But as the problems change, so too must the methods and disciplines we bring to these problems. Just as in the past, we need to be able to anticipate the challenges the Air Force will confront and recommend specific ways in which those challenges can be met. In doing so, we will be better positioned to help the Air Force develop effective strategies, cutting-edge technologies, efficient processes, and dynamic organizational constructs and support structures.

At RAND, our skilled and dedicated people continue to be our most valuable resource. They represent a wide range of academic disciplines and real-world experience and share a common desire to make a difference. They are as likely to be in the field, where the Air Force lives and operates, as they are at their desks or computers. They will address complex, challenging problems and will pursue them until they have found answers, sometimes uncomfortable answers.

It is this collective breadth of experience, depth of individual expertise, and desire to tackle the toughest issues that makes PAF uniquely well suited to helping the Air Force address its most difficult and important problems. At the same time, our long-standing partnerships with

our sponsors are what distingish our approach and enable us to make a difference with the Air Force, the nation, and sometimes the world.

This annual report highlights a number of our recent efforts and also profiles a few of the many RAND analysts who devote themselves to helping solve the Air Force's hardest problems. The common element for all the work featured in this report, and indeed for all our efforts, is our commitment to objectivity. It is the constant that has served as the foundation for Project AIR FORCE's reputation and its value throughout our six-decade partnership with the United States Air Force. Looking to the future, it will remain our greatest source of strength as we partner with the Air Force to focus on the nation's most challenging problems.

Andrew R. Hoehn
Vice President, RAND Corporation
Director, Project AIR FORCE

Building Partner Capacity

The Key to a Successful Counterinsurgency Strategy

In the popular imagination, insurgency seems to be some new and unusual form of warfare. Yet, as those who confront it directly know well, the history of insurgency spans centuries, continents, and societies. Ongoing U.S. operations in Afghanistan and Iraq have certainly given the problem particular immediacy, and that has added fuel to the current debate over the future role of the U.S. military in Iraq. But terrorism and insurgency will continue to present challenges around the world well beyond the current conflicts. What more can the U.S. military learn from the recent past and the present as it considers the future of counterinsurgency?

The U.S. Air Force Plays a Highly Important, but Indirect, Role in Counterinsurgency

Recognizing that the challenges modern insurgencies pose will likely continue, the Air Force asked PAF to help it prepare for the roles it may need to play in future operations. PAF researchers studied four major questions: (1) What threats do modern insurgencies pose to U.S. interests? (2) What strategies should the United States pursue to counter insurgent threats? (3) What role does military power play in defeating insurgencies? (4) What steps should the Air Force take to contribute most effectively to counterinsurgency? They concluded the following:

- The primary insurgent threat to the United States today stems from regional rebels and global terrorists who share a common ideology—political, religious, or otherwise. Global terrorists use local insurgencies as training grounds, for sanctuary, and to engage a global audience.
- The priority for U.S. counterinsurgency efforts should be the insurgencies motivated by radical Islam and global jihad. These are the ones most likely to find common cause with al Qaeda or other global militant groups.
- Previous experience with insurgencies has demonstrated that they are rarely defeated by outside powers. Rather, the best role for outsiders is indirect: training, advising, and equipping the local nation, which must defeat insurgencies politically and militarily.
- A precautionary strategy that seeks to defeat an insurgency in its early stages is the most cost-effective approach, in both lives and dollars.

Combat Aviation Advisors from the 6th Special Operations Squadron and regular army soldiers from Chad pose for a photograph in front of a Chad Air Force C-130.
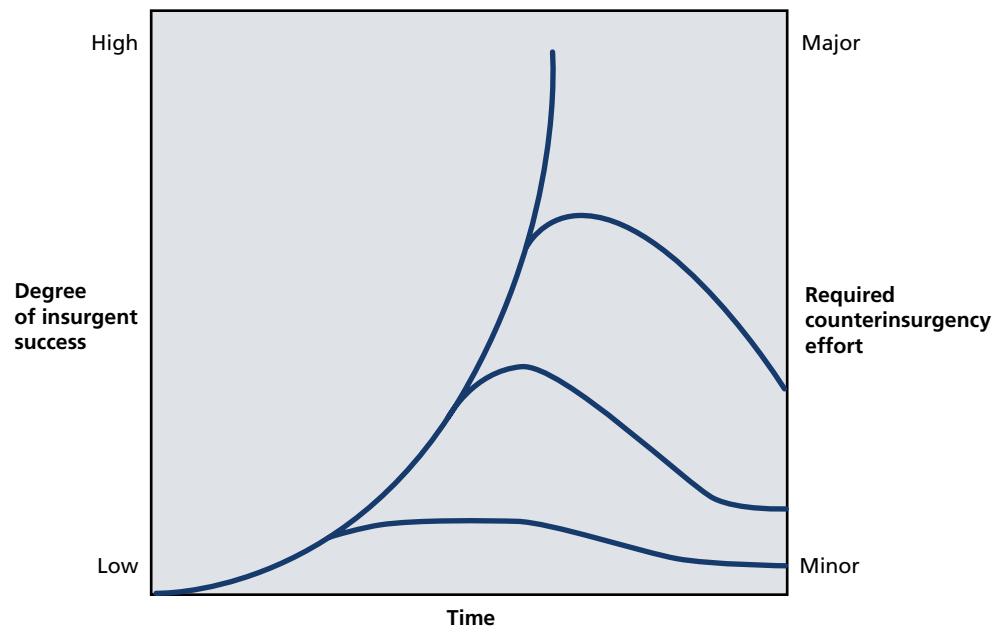
High — Major
Degree of insurgent success
Required counterinsurgency effort
Low — Minor
Time

Figure 1: This chart illustrates a simple insurgency that enjoys increasing success over time. The curves that branch away from the main curve illustrate the potential effects of intervening at different points. In the ideal situation, good government, a fair and just society, and economic opportunities would have prevented an insurgency from arising in the first place. Even these strong societies are likely to have their individual malcontents, but without some underlying grievances to engage a larger audience an insurgency will not gain traction. When insurgents find more-fertile soil in which to work, good intelligence and police work can stop the insurgency at an early stage, as shown by the lowest branching curve (although political, economic, and other reforms are still likely to be necessary to address the underlying roots of the insurgency). Over time, however, the risks and costs of countering the insurgency increase dramatically. The middle and highest branching curves illustrate the greater effort required and the greater risk associated with later interventions.

Opposite: Pilots are shown in the cockpit of a C-130 Hercules, which is capable of operating from rough dirt airstrips and is used for transporting troops and equipment into active theaters.

Figure 1 illustrates a simple insurgency that enjoys increasing success over time. The curves that branch away from the main curve illustrate the potential effects of intervening at different points. Over time, the risks and costs of countering the insurgency increase dramatically.

■ Because insurgencies are fundamentally driven by social, political, and economic issues, nonmilitary aid will often be most important, especially in the early phases of a rebellion. Support to the host nation's police, security, and intelligence organizations is especially critical and should precede or occur in parallel with military assistance.

■ Air power has much to contribute to countering insurgencies around the globe. It provides mobility, reconnaissance, strike capabilities, and other functions that greatly enhance the effectiveness of counterinsurgency ground forces. It also helps constrain the enemy's options. Therefore, advising, training, and equipping partner air forces to carry out these roles should be a key component of U.S. counterinsurgency efforts.

■ Advising and assisting missions, however, are rarely straightforward. Internal politics of host nations, lack of sufficient resources, or a reluctance to accept U.S. assistance can cause training to take longer than expected, require repeated missions, or lead to the postponement or failure of a mission.

■ The U.S. Air Force needs a broad set of counterinsurgency capabilities. Although training, advising, and equipping efforts will be the Air Force's most common role in counterinsurgency, experience shows that some situations require U.S. combat air power to team with indigenous or coalition ground forces or to participate in joint and interagency U.S. counterinsurgency operations.

It is important that the U.S. Air Force continue to consider how to meet the demand for air power in joint, combined, and interagency counterinsurgency operations and that other service and DoD-wide reassessments of the subject take the potential roles of air power fully into account. In particular, airmen should explore how air power might work in combination with other military and civil instruments to help avert the development of an insurgency or perhaps to check a growing insurgency long enough to allow political and social initiatives—the heart of any successful counterinsurgency strategy—to take hold.

The Air Force Should Take Steps to Enhance Its Counterinsurgency Capabilities

The Air Force possesses a broad range of capabilities, in both its special and general-purpose forces, that can make significant contributions to fighting insurgents. Bringing these capabilities to bear on the counterinsurgency problem will require treating counterinsurgency as a problem approaching the same importance as conventional warfighting, even though the manpower, funding, and force structure devoted to it will likely never need to be as large as those devoted to large-scale combat missions. To enhance its contribution to counterinsurgency operations, the Air Force should consider the following steps.

Air power has much to contribute . . . mobility, reconnaissance, strike capabilities, and other functions that greatly enhance the effectiveness of counterinsurgency ground forces.

Make counterinsurgency an institutional priority. Without regular emphasis from senior leaders, the institutional Air Force may continue to treat counterinsurgency either as something that only the Air Force Special Operations Command does or as a lesser included case that requires no special preparation. Major speeches, vision statements, personnel policy changes, and new programs will be necessary to overcome this perception.

Create organizations and processes to oversee Air Force counterinsurgency efforts. The Air Force will need new organizations to develop and oversee counterinsurgency policy and concepts,

Alan Vick

Alan Vick, senior political scientist at RAND, has been adapting military strategy in a rapidly changing world for nearly 25 years. Vick examines the roles of air and ground power in exceptionally difficult missions, such as urban combat, operations against elusive ground targets, and counterinsurgency. In these cases, existing strategies, doctrines, and concepts of operation may no longer be optimal. "Confronting these problems often involves rethinking the strategies and doctrines that may (or may not) have worked in the past and making them more effective for the present and future," he says. Therefore, his work often results in new ideas about service roles that cut through well-worn views based on "how things have always been." For example, a 2005 study coauthored by Vick, *Beyond Close Air Support*, describes an allocation of roles and closer coordination between the Air Force and the Army that would increase U.S. effectiveness against small, distributed forces—including insurgents—that operate in difficult terrain.

Vick points to his experience as important training. He served as an infantryman in the 82nd Airborne Division, U.S. Army, and came to RAND in 1983 with a doctorate in political science from the University of California, Irvine. He was PAF liaison to U.S. Air Force headquarters in the Pentagon and has filled several management roles in PAF.

Future-oriented thinking is not always easy. "Large organizations don't change their thinking—let alone their practices—overnight, even when the need is great," says Vick. "Our work often helps raise awareness, build consensus, and highlight options to solve emerging problems. But if we are thinking ahead, it may be several years before the policy issue becomes a priority and the organization takes action."

That has not been the case with *Air Power in the New Counterinsurgency Era*. The final report has been distributed to the Air Force, DoD, and the general public. Vick says that the response has been unusually rapid. He tells of one Air Force officer who went to Iraq as an advisor to the Iraqi Air Force. The officer said that all the people on his team were given a copy of Vick's report by the Air Force Special Operations Command with instructions to read it before they left. Once in Iraq, the team requested copies for the whole unit. Vick also recalls a letter from the vice commander of Special Operations Command. "He said that the Air Force needs to do five things, and he listed the five recommendations from our report. It doesn't mean they have done these things—big organizations don't necessarily move overnight—but it indicates that we raised the visibility of some options and that our recommendations resonated with Air Force leaders."

Reflecting on his career in PAF, Vick says, "It has been one interesting problem after another. The Air Force is a great research sponsor. They give us the freedom to think about cutting-edge problems, they listen, and they use our work." Vick plans to continue focusing on areas in which the United States, and especially the Air Force, face both daunting risks and opportunities to change their points of view.

to integrate efforts across the service, to coordinate with DoD and other agencies, and to execute counterinsurgency advisory and assistance missions.

Develop and nurture counterinsurgency expertise throughout the Air Force. Counterinsurgency expertise does exist in the Air Force, but, outside Special Operations Command, it is scattered and limited. Substantial counterinsurgency education should be a mandatory part of the curricula of the Air Force Reserve Officer Training Corps; the Air Force Academy; and all phases of Air Force Professional Military Education, from Squadron Officer School to the Air War College. Opportunities for more in-depth training and education will need to be developed, as will appropriate career paths for counterinsurgency specialists.

Create a wing-level organization for aviation advising. This is likely the single most important initiative the Air Force can take to enhance its own counterinsurgency capabilities. With a wing-level organization, the Air Force can increase its advisory capacity to meet the demand; expand aviation assistance to include institutional and higher-level advising; develop new counterinsurgency concepts and technologies for partner air forces; supervise an embedded advisor program; and offer sufficiently diverse opportunities to attract and retain the very best officers, noncommissioned officers, and civilian personnel.

Enhance Air Force combat capabilities for counterinsurgency. Although not likely to be called upon frequently, the Air Force needs the ability to conduct air operations in support of partner-nation forces and/or U.S. joint forces fighting insurgencies. The Air Force already has considerable relevant capabilities (e.g., the AC-130 gunship), and its modernization programs will enhance them further. Beyond that, specific technologies (e.g., foliage-penetrating sensors) and, most important, a deeper understanding of the insurgent phenomenon will increase the effectiveness of air power in future counterinsurgency operations.

Given the ongoing importance of counterinsurgency, the greatest institutional challenge for the Air Force will not be in acquiring major new weapon, sensor, or aircraft systems but rather in identifying and developing personnel who have the aptitude for this type of warfare and in creating organizations that can effectively advise, train, and equip partner air forces to wage internal wars that are ultimately theirs to win or lose.
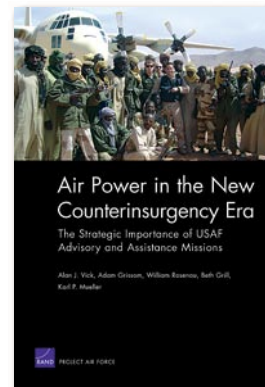
For more information, see

MG-509-AF, *Air Power in the New Counterinsurgency Era: The Strategic Importance of USAF Advisory and Assistance Missions*, by Alan J. Vick, Adam Grissom, William Rosenau, Beth Grill, Karl P. Mueller. Online at http://www.rand.org/pubs/monographs/MG509/

Threats on the Frontier

Identifying Ways to Reduce U.S. Exposure to Potential Space Attacks

Space may be the military high ground of the 21st century, but it is one with minimal fortifications and lookouts. The "troops" encamped there—satellites—are of great value for both their position and capabilities, but they may be vulnerable. Even as such space assets as the Global Positioning System (GPS) and satellite communications are making U.S. military forces in Iraq and Afghanistan more precise and responsive, some worry that the United States may be leaving itself open to a possible "space Pearl Harbor."

Protecting space systems is a formidable challenge, and such events as China's antisatellite weapon test in January 2007 make the possibility of successful attack seem all too real. But as DoD's executive agent for space, the Air Force is responsible for making sure that does not happen.

Adding fortifications—in the form of defensive capabilities—would be technologically difficult and politically sensitive. It would also add to the cost of these systems, which are already very expensive.

In the face of shrinking defense budgets, this leaves the Air Force to answer a set of difficult and interconnected questions: Where should it invest resources to develop an effective defensive capability in space? How can it ensure that such vital services as communications and position, navigation, and timing remain available to the warfighter if space systems are attacked? Can the U.S. military limit its dependence on space?

In answering these questions, space and space assets cannot be considered in abstract terms. What happens in space has real, immediate consequences for U.S. military personnel on the ground, in the air, and at sea. That makes it necessary to balance theoretical risks against an understanding of how these systems are actually used.

Defensive Counterspace Begins with Awareness

PAF is working to help the Air Force clarify and prioritize options for defending space assets effectively. One important area of interest is *space situational awareness*—the ability to know what is happening to U.S. satellites in orbit and how that affects users on the ground.

While engineers can determine whether a building has collapsed because of a natural disaster, design problem, or human action by directly

A low-flying weather-tracking satellite of the Defense Satellite Meteorological Program, which is supported by the 6th Space Operations Squadron at Schriever Air Force Base in Colorado. This unit analyzes weather data and transmits to active theaters to increase force responsiveness and flexibility.

examining the physical evidence, they cannot do the same for a silent satellite. The physical evidence is in orbit, out of reach. Satellites can go offline for many reasons, including failure of components or software; collisions with spacecraft debris or meteoroids; or deliberate attack, which might involve jamming or an antisatellite weapon.

Functionally, space situational awareness is intended to help the satellite operators discriminate among such events and, if possible, detect threats before they materialize. If a threat is detected, the ideal result would not only indicate that a satellite is under attack but also describe the type of attack and its source and would do so soon enough to permit a timely response. Depending on the exact circumstances, that response could range from protecting the satellite to restoring it to finding a work-around—whatever is necessary to maintain services to the warfighter. This awareness can also help asset managers choose among defensive options, measuring them against the information available about the attack and the timing.

PAF's research in this area is intended to help narrow the field of potential technology investments to those that offer the most effective situational awareness and support the most effective defensive capabilities.

Space Is Not a Fortress

While space may be the best way to provide certain services to the warfighter, it is not the only way. Planners and controllers can take advantage of this by looking beyond what is unique about space systems to what they have in common with other systems. Integrating space, air, and ground systems with related capabilities is one way to help ensure that warfighters can continue to receive vital services if space systems fail.

That seems straightforward enough, but because of the physical and technological differences between the domains, space-based and terrestrial (air- and ground-based) systems may be managed separately, even when they have the same mission. For example, military communications assets are managed by different organizations.

PAF researchers are attempting to identify ways in which space-based and terrestrial communications, such as ground links and airborne relays, can function as a total system, so that the whole can overcome problems in any one area and keep providing services to users.

While it is too soon to see institutional changes result from this research, interest in collaboration between space and terrestrial organizations is already increasing. Such cooperative problem-solving across domains can mitigate the damage that a space-capable enemy might try to cause. If an enemy knows that disrupting a U.S. satellite system will not reduce the nation's fighting ability, he might conclude that developing a counterspace capability is not worth the effort.

Opposite: Spc. Kerry Lampkin positions a satellite communications antenna during an operation to find weapon caches and known terrorist suspects within the village of Malhah in Kirkuk province, Iraq, on December 22, 2006.

Below: Staff Sgt. Cristina Kavanagh and 1st Lt. Tanya Frazier provide space-based theater ballistic warning to U.S. forces in the Southwest Asia theater from the Combat Operations Space Cell inside the Combined Air Operations Center.

Greater Reliance on Space Will Not Always Improve Service

As part of its ongoing research, PAF has been providing technical support for and an independent assessment of a U.S. Strategic Command investigation of whether DoD should invest in more GPS satellites to help combat soldiers navigate in urban settings. The "canyons" that the closely spaced buildings of a city create interfere with GPS signals, with the buildings either blocking the signals entirely or allowing them to bounce off various surfaces, resulting in inaccurate coordinate readings.

Initial PAF research indicates that additional satellites would not solve the problem and that integrating space-based and terrestrial techniques is necessary. Even if it were cost-effective, adding more GPS satellites alone may not change the way ground forces operate in urban environments. In certain situations, some old-fashioned methods, such as using local guides and studying imagery, and emerging technologies, such as image-matching cameras mounted on soldiers' helmets, could be more useful than GPS.

Lara Schmidt

Lara Schmidt is one of the newer members of a team of PAF researchers who are helping the U.S. Air Force map out the rapidly developing frontier of potential threats in space. With a doctorate in mathematical statistics from the American University, her original intention was to pursue an academic career. But a position at the U.S. Naval Observatory working on atomic clocks and GPS brought her face to face with the real-world challenges that the engineers and users of the models she was designing have experienced. "I was suddenly surrounded by physicists and engineers who spoke a different language, but the reasoning was the same," she recalls. Determined to bridge the gap, she read everything she could find on GPS and other satellite systems and spent a great deal of time in the lab testing how statistical theories played out in the physical world.

An essential part of her education was to understand what it means to be a user of space-based capabilities. According to Schmidt, having to wake up in the middle of the night to solve a problem helps you understand something: "You begin to focus on the system, not just as a piece of hardware, but as a capability that people on the ground are counting on, possibly in life-or-death situations." Soon Schmidt was expanding her work from GPS to other military systems, such as satellite communications.

It was this combination of analytical skill, operational knowledge of space systems, and ability to master new disciplines that made Schmidt attractive to RAND. Myron Hura, a senior engineer at RAND since 1987, was among the first to involve Schmidt in PAF's space research. "Lara came in as a statistician," he recalls. "She has a mathematician's ability to structure and carry out analyses. But she also has a specific knowledge of space systems that gets deeper all the time. It allows her to see the bigger operational picture behind the analysis." Since joining RAND in 2003, Schmidt has worked with Hura and other senior PAF researchers, such as Russell Shaver and Gary McLeod, on a series of projects that are examining problems involved in developing, utilizing, and protecting military space capabilities.

Reflecting on the future security of U.S. space assets, Schmidt is optimistic, despite the January 2007 Chinese antisatellite weapon test. "Most Americans don't worry about how much they themselves rely on space systems like GPS and satellite communications every day," she says. "We want to make sure they don't have to."

Urban warfighters are asking for positioning systems that integrate the global availability of precise GPS solutions with rich local information. For example, while GPS may help find a general location, determining which door is the correct one to enter requires integrating ultra-high-quality position data with intelligence and situational awareness information. Instead of seeking space-based solutions alone, PAF has recommended a more-integrated approach that combines GPS and visual positioning methods with other information services.

Here, as in every domain—space, air, land, or sea—the key question is whether increased dependence on a space system benefits the warfighter. Being able to provide both space and terrestrial capabilities may help limit America's possible exposure to space attack and may reduce some of the financial burden that the Air Force now carries.

A Delta II launch vehicle carries a GPS navigation satellite into orbit from Cape Canaveral Air Force Station, Florida.

What Is the Right Number and

Complex Analysis for Fundamental Needs

Mix of Fighter Pilots?

Maintaining a sufficient number of pilots ready to undertake the full range of Air Force missions is far more complex than counting aircraft and pilots and making sure the two numbers match. Rather, it requires careful development of personnel management policies that

- enable new pilots to become fully trained expeditiously but without overtaxing the system
- ensure a balance among junior, midcareer, and senior personnel in the pipeline
- produce enough pilots who will ultimately be capable of filling staff positions for which flying experience is a prerequisite.

For nearly a decade, PAF has been helping the Air Force address this issue, particularly in the area of fighter-pilot production, where the problems seem to be most acute. Using dynamic models that quantify the effects of year-by-year policy changes, PAF's most recent research examined the active-duty training system. At issue is the fact that, at any one time, there may not be enough resources to handle the number of new, inexperienced pilots. Such a system overload could degrade training and combat capabilities. But there is more than one way to address this problem, and PAF has offered options that can help satisfy emerging needs for airmen with fighter-type skills.

New Fighter Pilots Are Expected to Become Experienced During Their First Duty Assignments

Air Force pilots begin their training with a year-long course in the basics: takeoff, landing, flying in formation, and flying on instruments. During this period, individuals who demonstrate the skills needed to become fighter pilots are identified. After graduation, these candidates enter the next phase of training, learning to fly fighter aircraft and to understand the combat mission. Finally, these new pilots join fighter units, flying under the supervision of experienced pilots until they meet specific criteria—generally, 500 hours in the aircraft—to be considered experienced themselves. Ideally, they achieve this status during their first three-year assignment.

Capt. Aaron Manley motions to his crew chief from the cockpit of his F-15 Eagle fighter jet on Wednesday, June 14, 2006, during an operational readiness inspection at Portland Air National Guard Base in Oregon. Traditionally, to be considered "experienced," pilots must have 500 hours in the aircraft.

Most fighter pilots go on to a second assignment, in which they serve as either instructor pilots in the first course, air liaison officers with the Army, or "pilots" for unmanned aerial systems. Before returning to fighter units for a second flying assignment (as experienced pilots), they attend refresher courses in their fighter aircraft. Normally, it is only after a second assignment in a fighter unit that a pilot would be eligible to fill a staff position at command headquarters or in the Pentagon.

Fighter Units Require the Proper Ratio of Experienced and Inexperienced Pilots

Each unit is allotted a fixed number of aircraft and a specific number of flying hours per year. Flying hours and aircraft must be shared, and inexperienced pilots must fly under the supervision of experienced pilots. However, if the balance between experienced and inexperienced pilots dips too heavily toward the latter, the former will fly more hours than they need to maintain proficiency, while the latter will not fly enough to become proficient. Thus, the rich get richer and the poor get poorer.
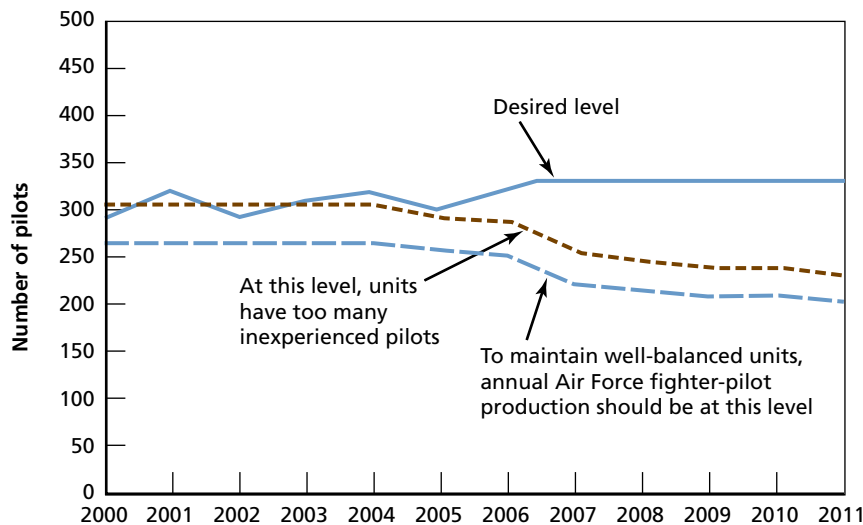
If resources were unlimited, purchasing more aircraft or funding more flying hours would solve the problem. Budgeting realities, however, mean that the total number of aircraft in the inventory and the total number of flying hours available will steadily decrease for at least the next ten years. While the number of cockpits is decreasing, the need for people with fighter-pilot skills in a variety of other positions is not, so the Air Force would like to maintain the same fighter-pilot production goal that has existed since 2000 (330 fighter pilots per year).

Maintaining Projected Fighter-Pilot Production Levels with Reduced Aircraft Inventories and Flying Hours Can Harm Training and Combat Readiness

The difficulty here is that, over the next few years, the declining aircraft inventory can support only active-duty fighter-pilot production at the level indicated by the lowest line in Figure 2. Trying to push more pilots through the system at the level indicated by the brown dashed line would stress the units because it would be difficult for inexperienced pilots to achieve and maintain readiness for combat. The Air Force's desired production level exceeds both the "healthy" rate and the rate that causes stress.

In 2006, the Air Force made two policy changes that affected the fighter-pilot training system. Managers of F-15 training decided that, because high-fidelity simulators had become so effective, new pilots could be considered experienced after achieving 400 flying hours and 100 simulator hours, rather than the 500 flying hours that had been required in the past. This measure would have made it easier to produce experienced pilots during the first assignment. Unfortunately, budget reductions forced the Air Force to cut the number of flying hours available to units by 10 percent.

On balance, these changes still lead to the following unacceptable conditions, especially in F-15C and F-16 fighter units:

Figure 2: High levels of fighter-pilot production have a negative effect on pilot training. Trying to push more pilots through the system at the level indicated by the brown dashed line would stress the units because it would be difficult for inexperienced pilots to achieve and maintain readiness for combat. The Air Force's desired production level exceeds both the "healthy" rate and the rate that causes stress.

- Fighter units will become "overmanned," having about 30 percent more pilots than they are authorized to have for the assigned numbers of aircraft.
- Inexperienced pilots will be able to fly only about five sorties per month, rather than the eight to ten considered necessary to maintain desired skills.
- The low flying rate will mean that new pilots cannot become experienced in their first three-year assignments.
- The ratio of experienced to inexperienced pilots will drop to 20 percent, even though at least 45 percent is considered necessary for maintaining unit health.
- Most authorized positions in a unit will be filled by first-assignment pilots, thus making it very difficult for Air Force pilots to get a second flying assignment and severely reducing the number of individuals qualified for staff positions at command headquarters or in the Pentagon.

An Air Force Working Group on Aircrew Management Recommended Several Initiatives That Would Lead to a Balanced System

In recognition of these problems, the Air Force established a working group to address the management of personnel who fly aircraft in general, although the emphasis tended to be on problems within the fighter community. PAF supported this effort and provided the analytic underpinnings. The working group developed several recommendations that would "balance" flow through the fighter-pilot training system.

The first recommendation was to limit the number of pilots that go through the active-duty system to about 200—the number that PAF modeling indicated was all the system could sustain in light of the decreasing number of aircraft available. The next recommendation was to divert an additional 50 to 75 fighter pilots per year to Guard or Reserve units for their first assignments, then return to active-duty units.

Researcher Profile

Sometimes a group of researchers is particularly well suited to attack a given research problem, and this is especially so when personal experience can be brought to bear. That is definitely the case in PAF's research on Air Force pilot training. Team leader Bill Taylor has conducted PAF studies of personnel development and management since the early 1990s, and he is currently the PAF liaison at Langley AFB, home of Air Combat Command. Before coming to RAND, Bill was a career officer and fighter pilot in the Air Force. Retiring with the rank of colonel, he logged 4,600 flying hours, flew 156 combat missions in the F-4D in Southeast Asia, and was awarded the Legion of Merit and the Distinguished Flying Cross. John Ausink was also an Air Force officer. He spent part of his career as an instructor pilot and was (like Bill) an associate professor of mathematics at the Air Force Academy. Both Bill and John have an insider's appreciation of the entire operational training environment.

Jim Bigelow has been at RAND for nearly 40 years and is one of its most talented modelers. He earned his doctorate in operations research under the direction of George Dantzig, the world-famous developer of linear programming. Within PAF, Jim has applied his skills to create a dynamic model that shows effects over time of various actions, including aircraft reductions, on the Air Force's ability to produce experienced fighter pilots. The goal is not only to understand problems that currently exist in the system, but also to anticipate those that may occur in the future. A particular strength of this model is that Jim can readily adapt it to explore and evaluate the results of proposed policy changes. He points out that, "Because we can turn things around so quickly, the results can become part of the dialog. The Air Force doesn't have to wait six months to see how some of its ideas will affect the desired outcome."

In March 2007, the results of this study were briefed at an aircrew management summit convened by the Chief of Staff of the Air Force. Bill Taylor described the experience as very satisfying, because he felt that the Air Force fully recognized the long-term consequences of a mismatch between requirements and inventory and would be taking steps to mitigate the problem.

What's next? The research team thinks that a good next step would be to take a hard look at the other side of this issue: the long-standing practice of placing experienced fighter pilots in nonflying jobs for which their knowledge and skills are considered highly beneficial. Working with the Air Force to build a model that follows pilots through this second phase of their careers could help identify the specific skills each job requires and determine whether it really needs to be filled by an experienced pilot. This information would be an important way to illuminate the forcewide implications of personnel decisions related to pilots.

From left to right: Bill Taylor, Jim Bigelow, John Ausink

Anticipating the needs of unmanned systems, the working group also recommended sending 50 to 100 pilots to unmanned systems after initial pilot training. These pilots would gain the fighter-related skills that the Air Force considers necessary for emerging staff positions without encumbering the fighter training system.

These three recommendations would allow the development of 300 to 375 people per year with fighter-type skills—about what the Air Force thinks it needs—but the working group also recommended that the Air Force define more clearly the nonflying positions that require fighter pilots. Some of these positions might be filled by personnel with other backgrounds, by non–active-duty fighter pilots, or even by retired fighter pilots who have been hired as government employees. Furthermore, it might prove possible to eliminate some of these positions altogether.

The Working Group's Initiatives Would Have Specific Benefits

The PAF team again used dynamic modeling to examine year-by-year changes, showing how the initiatives described above could improve the training and readiness of individual fighter units. The team assessed how these changes would affect the problems outlined above.

Manning. Will there be too many people in the unit for the number of aircraft available? With no changes, F-16 units will have 40 percent more pilots by 2013 than are authorized. With the changes, the units will have the correct number. The situation for F-15 units is approximately the same.

Training. Will inexperienced pilots be able to fly the recommended number of sorties per month? With no changes, these pilots will fly only about four sorties per month by 2014. With the changes, they will be able to fly much closer to the ten that they need. Again, these profiles are basically the same for F-15 units.

Experience. Will inexperienced pilots be able to fly enough hours to become experienced? After 2009, with no changes, pilots will leave their units after a 36-month first assignment without the necessary experience. With the changes, they will be able to satisfy the requirements within 32 months.

Ratio of experienced to inexperienced pilots. With the changes, this ratio climbs to 50 percent or above after 2009, comfortably over the desired minimum of 45 percent. With no changes, the ratio dips below 30 percent.

Positions filled by first-assignment pilots. Finally, with the changes, the percentage of positions filled by first-assignment pilots drops below 60 percent after 2010, leaving more room for experienced pilots to return to fighter units for second assignments to gain the additional experience they need later in their careers.

Denying America Access

China's Efforts to Limit U.S. Power in the Western Pacific
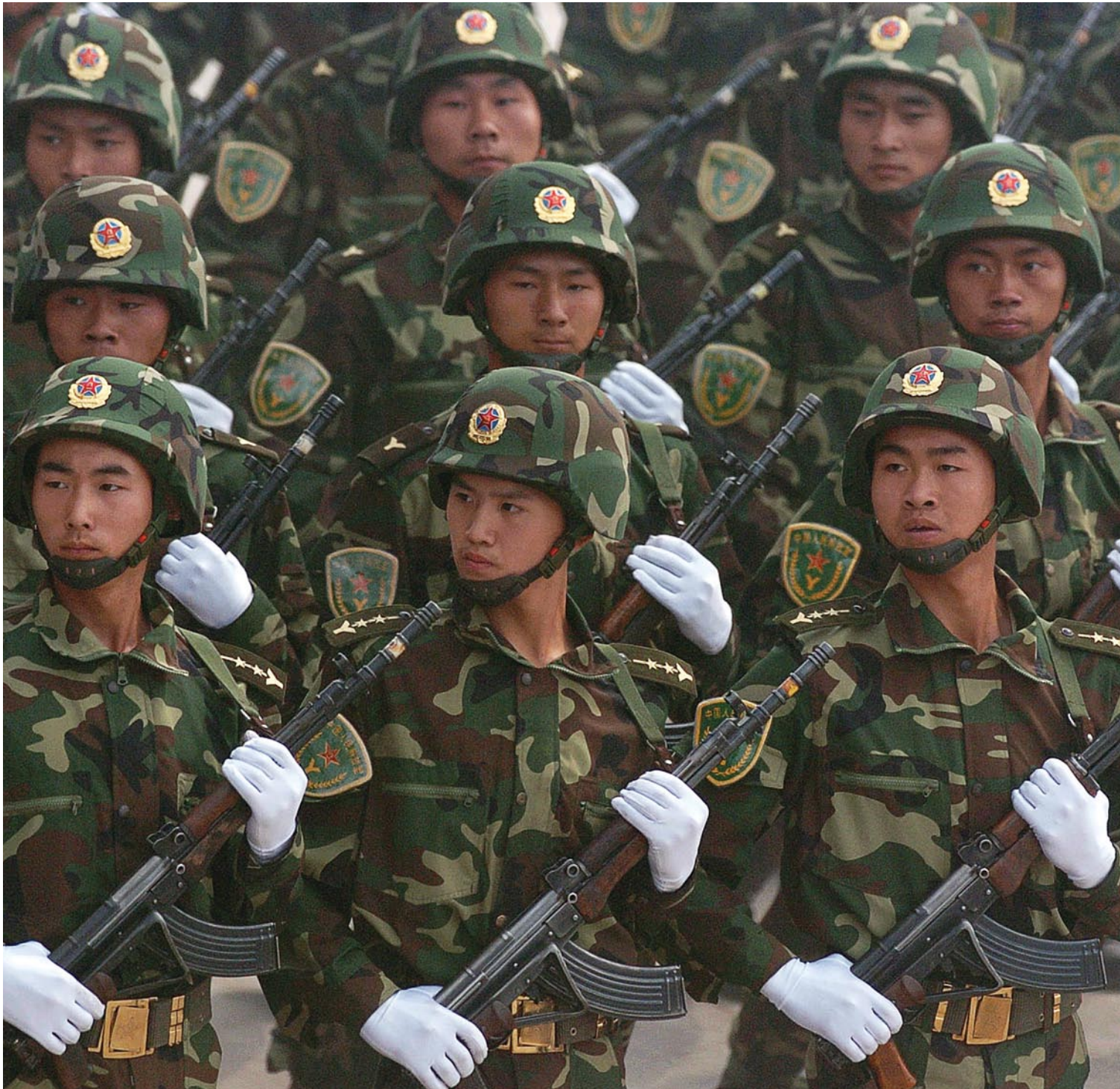
F or more than a decade, U.S. defense analysts have debated how China would approach closing the gap between its military capabilities and those of the United States. The country's remarkable economic expansion and heavy investment in modern military equipment suggest that China has developed options that would make it a formidable adversary, particularly in a conflict over Taiwan, which the United States remains committed to defending should China attempt to unify the island to the mainland by force.

As part of that debate, analysts have been concerned that China might attempt to circumvent a force-on-force confrontation with the United States and instead try to achieve victory by preventing the U.S. military from getting to the fight. *Antiaccess* strategies involve seeking to slow the deployment of opposing forces into a theater, to prevent them from operating in certain locations in the theater, or to cause them to operate from further away than they would prefer.

Instead of trying to deduce from known capabilities and the writings of Western analysts what the Chinese might be thinking or doing on this matter, the team instead went directly to the source. Chinese-literate PAF researchers read and analyzed the publications of the Chinese military to determine what they have to say about this matter.

China Sees Antiaccess Strategies as a Way to Exploit U.S. Vulnerabilities

Chinese analysts are keenly aware that the People's Liberation Army (PLA) still lags the U.S. military in terms of technology, doctrine, training, and experience and that any conflict with the U.S. military will pose extreme challenges. To defeat a technologically superior enemy, the PLA has focused on devising strategies that maximize its relative strengths and create opportunities to exploit an opponent's perceived vulnerabilities. In terms of antiaccess measures, this means attacking the facilities and resources that the United States relies on for rapid deployment and sustainment of military forces.

Information systems. PLA analysts believe that attacks against information systems can delay the deployment of U.S. military forces by

Chinese People's Liberation Army (PLA) reservists attend a military exercise marking the 80th anniversary of the founding of the PLA in Taiyuan, capital of north China's Shanxi province, on Wednesday, August 1, 2007.

disrupting communications or denying access to information on enemy whereabouts. Targets could include computer systems; command and control nodes; or space-based intelligence, surveillance, and reconnaissance and communications assets.

Logistics systems. Noting the great distances U.S. forces would need to traverse in a conflict with China, PLA analysts envision attacking storage depots, repair and maintenance facilities, and air or sea supply missions.

Air bases and seaports. Chinese writers state that attacking these targets would be the most efficient way to gain air or sea superiority because it would prevent or disrupt both the inflow of personnel and supplies and the basing of air and naval assets.

Seagoing naval assets. Chinese sources describe the central role that aircraft carriers sometimes play in conflicts. Air- and sea-launched cruise missiles, submarine-launched torpedoes, and ballistic missiles are discussed as possible anticarrier weapons.

In addition to military strategies, China might use diplomatic and political strategies—including threats of force—to try to deny the United States the use of or limit its ability to use its forward bases, most notably those in Japan.

The threat of a Chinese antiaccess use of force against the United States becomes starker in light of the military capabilities that China has already acquired or is in the process of developing. These include highly accurate conventional ballistic missiles, long-range surface-to-air and air-to-air missiles, land-attack cruise missiles, long-range strike aircraft with precision-guided munitions, submarines and surface warships with long-range supersonic antiship cruise missiles, advanced satellite and airborne

surveillance and reconnaissance systems, cyber-attack capabilities, and antisatellite weapons. The Chinese may also someday be able to strike ships at sea with ballistic missiles. These capabilities will greatly enhance China's potential to deter the United States from joining a fight in the western Pacific.

Antiaccess Strategies Could Result in Defeat for the United States

Defeat, in this sense, does not necessarily mean the destruction of U.S. combat capability. Antiaccess strategies could make it possible for China to accomplish its military and political objectives while preventing the United States from accomplishing its own objectives. In many eyes, that is victory enough.

The region over which China could act, the "Dragon's Lair," is immense and populated with U.S. interests. The map on page 27 shows the portions of the western Pacific that are most vulnerable to Chinese antiaccess measures. Antiaccess measures could severely degrade the ability of U.S. forces to operate from airfields in Okinawa, South Korea, and the main islands of Japan; impede the deployment of forces to forward operating locations; degrade command and control, early warning, or supply capabilities; and prevent naval surface assets from operating in waters near China.

The United States Can Use Existing Capabilities to Mitigate the Effects of Antiaccess Tactics

PAF analysts suggest that the United States can do much to mitigate the potential effects of an antiaccess strategy, should China choose to take such measures in a future conflict. Near-term steps that make use of existing capabilities and forces could include the following.

The threat of a Chinese antiaccess use of force against the United States becomes starker in light of the military capabilities that China has already acquired or is in the process of developing.

Strengthen Passive Defenses at Air Bases

The United States should strengthen runways against penetrating submunitions, increase runway repair capacity, construct enough hardened shelters to house and protect aircraft, and construct underground fuel tanks.

Deploy Air and Missile Defense Systems Near Critical Facilities

The capability to intercept ballistic missiles could prevent Chinese attacks from shutting down runway operations, thus enabling U.S. fighter aircraft to defend bases from cruise-missile and aircraft attacks.

Diversify Basing Options for Aircraft

This step would force China to distribute its antiaccess capabilities over a larger set of targets and would minimize U.S. risks in any one location. The United States should also consider forward-deploying an additional aircraft carrier in the Pacific to enable a faster response in the event of a Chinese preemptive attack.

Strengthen Defenses Against Covert PLA Operations

Covert attacks on U.S. airfields, command posts, communications links, maintenance facilities, and other key resources located outside U.S. territory would generally have to be launched from within the host nation. Therefore, the United States should ensure that its hosts are prepared to prevent and respond to such attacks.

Reduce Vulnerability of Naval Forces to Attack While in Port

Periodic mapping of the ocean floor would enable rapid detection of any new objects (such as mines), and hydrophones installed near harbor mouths would enable detection of submarines. In addition, U.S. naval forces in the western Pacific—including those in port—should immediately go on heightened alert whenever there are indications that China may be preparing to use force against another country. This will help mitigate the threat of a Chinese surprise attack against U.S. naval assets.

Reduce Vulnerability of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Systems

The enforcement of proper security practices, such as software encryption and isolation of critical systems from publicly accessible networks, can significantly reduce vulnerability to Chinese attack. Given the possibility that China might succeed in disrupting these systems, however, the U.S. military should maintain and exercise the ability to conduct operations without continuous, high-bandwidth communications between units.

Deter and Mitigate the Potential Effects of High-Altitude Nuclear Detonations

One possible means of disrupting information systems is by detonating nuclear warheads at high altitudes, which is within Chinese capabilities. The United States should make it clear that it would view such an action

RUSSIA

Misawa Air Base

MONGOLIA

Naval Air Facility Atsugi

Yokota Air Base
Fleet Activities Yokosuka

Osan Air Base

Marine Corps Air Station Iwakuni
Fleet Activities Sasebo

Kunsan Air Base

CHINA

Kadena Air Base

PACIFIC OCEAN

MYANMAR

PHILIPPINES

• Andersen Air Force Base
Naval Base Guam

THAILAND

VIETNAM

as an actual nuclear attack and would consider retaliation in kind to be a justifiable act of self-defense. In case deterrence fails, however, the United States should ensure that all its military systems are hardened against electromagnetic pulse.

Bolster the Capabilities of Allies to Defend Themselves Against Attacks by Missiles, Aircraft, or Special Operatives

The United States should help the military and security forces of regional friends and allies ensure that they are prepared to defend their airspace against Chinese missiles and aircraft, to counter covert attacks originating from their own territories, and to clear their ports or harbors of mines.

U.S. policymakers should openly publicize these steps to reduce the likelihood that China might undertake actions that would result in a confrontation with the United States.

New or Improved Capabilities Would Significantly Reduce the Antiaccess Threat

In addition to mitigating the potential effects of a Chinese antiaccess strategy using existing means, the United States can further protect itself by acquiring or improving several important capabilities:

■ Advanced ballistic missile defenses would reduce the ballistic missile threat to air bases; to C4ISR and logistics facilities; and, if China acquires the capability, to ships at sea.

■ An advanced capability to detect, identify, and attack mobile time-sensitive targets would reduce the ballistic missile threat to air bases; to C4ISR and logistics facilities; and, eventually, to ships at sea.

■ Advanced land-based and advanced shipborne cruise-missile defenses would reduce the cruise-missile threat to air bases, to C4ISR and logistics facilities, and to ships at sea.

Map of the "Dragon's Lair" showing some portions of the western Pacific that are most vulnerable to Chinese antiaccess measures. Antiaccess measures could severely degrade the ability of U.S. forces to operate from airfields in Okinawa, South Korea, and the main islands of Japan; impede the deployment of forces to forward operating locations; degrade command and control, early warning, or supply capabilities; and prevent naval surface assets from operating in waters near China.

Roger Cliff

How do you take a problem that may or may not materialize ten years from now and turn it into something you can begin to deal with today?

Roger Cliff has been asking—and helping to answer—that question with respect to China for the past decade. Cliff is a senior political scientist at RAND whose career has coincided with the development of a center of excellence for strategic studies on China in PAF. He led the team that investigated China's antiaccess strategy.

"After the Cold War, defense analysts began to suspect that China was the only country in Asia, and possibly in the world, that could pose a significant military threat to the United States," he recalls. "But the threat seemed remote. China was still very far behind the United States economically and militarily."

To help it make force-planning decisions that would need to be made years in advance of any threat materializing, the Air Force decided to invest in a long-term series of studies on China in PAF. The purpose was to monitor China's growth, discern developments in its military strategy and capabilities, assess the potential implications for U.S. security and interests, and recommend appropriate force postures to counter or mitigate threats. In this way, the China research would resemble the Soviet studies that RAND performed in the 1950s.

Cliff joined RAND in 1997, as the China research was getting under way in earnest. He had just completed his doctorate in international relations at Princeton, where he focused on China's relationship with Taiwan. Since then, he has worked with other RAND analysts, such as David Orletsky, Evan Medeiros, Keith Crane, and David Shlapak, on projects studying the implications of Chinese arms sales, the military potential of China's commercial technology, China's military modernization efforts, and the future of U.S.-China relations after the resolution of Taiwan's status.

For Cliff, the key to this research lay in making the connection between China's political and strategic thinking and the military operational implications that form the basis of force planning decisions. "It's easy for regionalists like me to make predictions," he says, "but the recommendation that most often comes out of that approach is to continue to pay close attention to the region. Our research has to go beyond that." Cliff gained a heightened appreciation for this conclusion during the two years he spent on loan from RAND to the Office of the Secretary of Defense, where he worked with military and civilian planners on projects beyond Asia involving the U.S. intelligence community and the 2001 Quadrennial Defense Review. "After that experience, I had a much better sense of what planners need from us and the way that operations analysis fits into our regional work on China," he says. "It requires another level of translation, first from Chinese to English, and then from Chinese political and doctrinal writings to real military challenges that the U.S. armed forces have to be prepared for." As a project leader, Cliff puts this into practice by bringing together RAND experts from both regional and operational disciplines.

The approach Cliff and his colleagues (who included Mark Burles, Michael Chase, Derek Eaton, and Kevin Pollpeter at the time of the antiaccess study) are taking appears to be paying off. The Air Force and other services have been adopting measures to mitigate the potential effects of China's antiaccess strategy, such as deploying Patriot antiballistic missile systems in Okinawa and forging a new agreement with Japan for contingency access to some of its airfields in case of a military conflict in the region.

Cliff expects that his team's approach will continue to yield actionable recommendations for the Air Force and DoD, especially with respect to China's potential future air, missile, and space power. "The Air Force deserves credit for continuing to stay focused on this issue despite more immediate challenges, such as Iraq," he says. "Chinese strategy is evolving as the situation around the world is evolving. Our job is to help the U.S. military make sure it's prepared to stay ahead of the curve."

- Advanced antisubmarine warfare and minesweeping capabilities would reduce the submarine and mining threats to key surface ships and ports and to U.S. submarines.
- Counters to antisatellite attacks against U.S. assets and a U.S. antisatellite capability would, respectively, reduce the threat to U.S. satellites and ships at sea (particularly aircraft carriers, which may be targeted from Chinese satellites).
- A highly capable long-range air-defense capability and counters to long-range surface-to-air and air-to-air missiles would reduce the threat to U.S. intelligence, surveillance, and reconnaissance aircraft and enable the U.S. military to defend airspaces near China even if Chinese antiaccess tactics against airfields and aircraft carriers were successful.
- Early strategic and tactical warning capabilities would substantially reduce the potential effects of a wide range of Chinese antiaccess measures.

The possibility of a Chinese antiaccess strategy is more than hypothetical. Yet there is much the United States can do to prevent such a strategy from succeeding. Some of the measures cost relatively little, while others will require substantial resources and even rethinking of operational doctrine and plans. However, failure to respond to the Chinese antiaccess threat will put potential U.S. military operations against China at increasing risk, particularly as China's military capabilities increase. The Chinese antiaccess threat can be overcome if the U.S. military devotes the necessary thought and resources to defeating it.
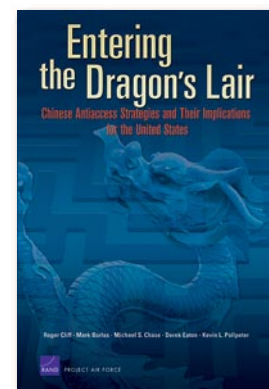
For more information, see

MG-524-AF, *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States*, by Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, Kevin L. Pollpeter. Online at http://www.rand.org/pubs/monographs/MG524/

Command and Control of Air

A Global Approach Can Make the AOC System More Flexible and Efficient

During the past decade, the U.S. combatant commanders (COCOMs) have come to rely on having individual air and space operations centers (AOCs) as the planning and execution engine of their air campaigns. As the locus from which the joint force air component commander directs air, space, and cyber operations, their value continues to be demonstrated in Iraq and Afghanistan and other operations around the world.

Planned reductions in the Air Force's budget and manpower, however, make it difficult to continue operating these individual AOCs in their present form. Therefore, the Air Force's Command and Control General Officer Steering Group asked PAF to help find more efficient and effective ways of meeting the COCOMs' needs. In particular, the Air Force wanted PAF to examine whether it was possible to consolidate certain AOC activities, enabling crew reductions and other efficiencies, without sacrificing the vital functions AOCs currently perform for COCOMs.

PAF Worked with the Air Force at Many Levels to Define Requirements and Alternatives

By definition, AOCs encompass a variety of mission types and involve people and interests from many parts of the Air Force. Defining workload requirements and constraints and identifying potential alternatives for meeting these needs demanded close collaboration between the PAF research team and Air Force leaders and staff officers around the world.

Researchers interviewed the commanders and staff officers of every operational AOC to capture theater-specific workload requirements and to understand resource, cultural, technological, and political constraints. They also met with numbered air force commanders and with staff officers from Headquarters Air Force, all of whom provided essential data and other guidance. The team used defense guidance and planning scenarios to model future AOC workloads. These scenarios varied according to the type of operation; the number and type of U.S. air assets required; the timing, intensity, and duration of the operation;

The Combined Air Operations Center at a forward-deployed location in Southwest Asia is the "nerve center" for aerial missions for operations Iraqi Freedom and Enduring Freedom. Center officials also control humanitarian-relief missions in the Horn of Africa.
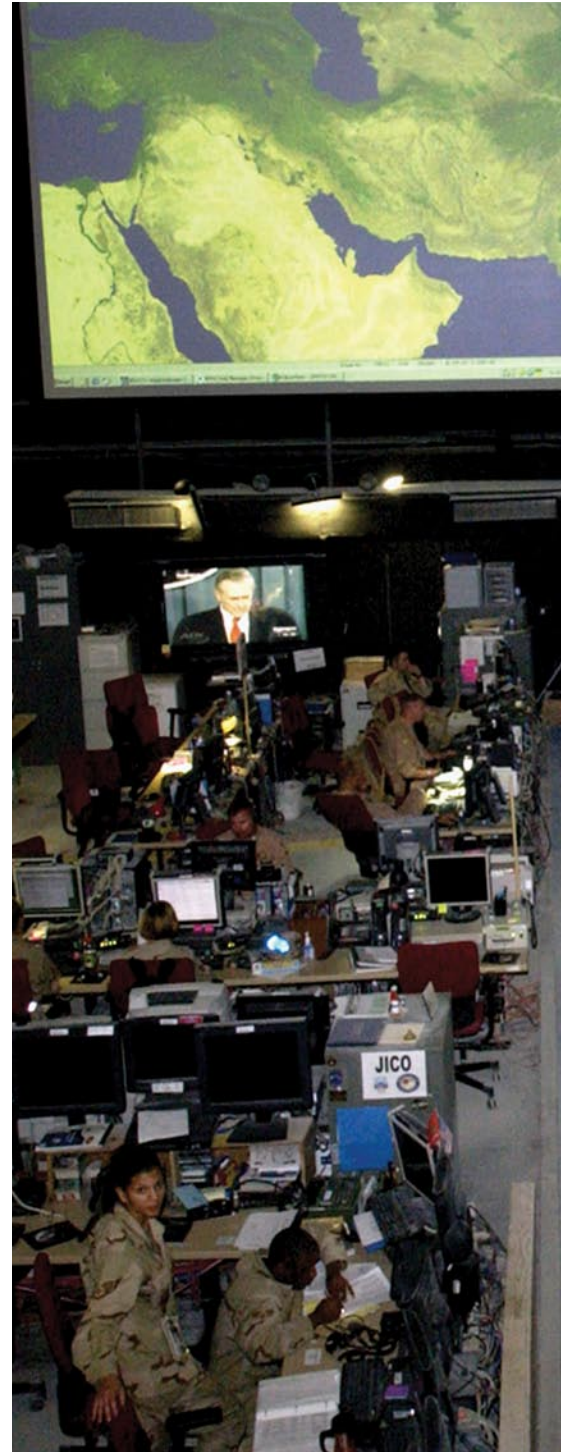
and Space Operations

and the AOC responsible for command and control of the operation. The purpose was to form a realistic picture of the demands that might be placed on AOCs to understand the amount of risk involved in adopting a given posture.

Throughout the project, researchers consulted with members of the General Officer Steering Group and with several senior Air Force mentors drawn from a select group of retired general officers who provide experience-based insights to the Air Force leadership. These regular consultations were valuable because the generals served as a sounding board and provided guidance, enabling the PAF team to refine its AOC alternatives and ensure that its proposed recommendations were both realistic and implementable.

PAF Identified Potential AOC Efficiencies

The researchers concluded that consolidating certain AOC personnel and processes can offer efficiencies while still providing needed capabilities. These consolidation options fall into four areas.

Reducing AOC Crew Size

The staffs of six AOCs could be reduced without significant capability degradations. PAF presented a range of options that could reduce personnel by up to 7 percent of current manpower requirements for all AOCs, depending on the amount of risk the Air Force is willing to assume over the range of scenarios for which it must be prepared. Some AOCs, including the Space Operations, Tanker and Airlift Operations, Special Forces Operations, and Homeland Security AOCs, are correctly sized for their current workloads, and staffing should not be reduced.

Performing Certain AOC Functions Off-Site

Some activities that do not require face-to-face interaction with the joint forces air component commander or the AOC commander could be relocated and consolidated. The resulting pool could be based either in the United States or at another location away from the area of operations, and the staff could support several COCOMs, as needed. As a result, the COCOMs would still have access to flexible, adaptable, and tailored AOC capabilities, but because not all the commands will need all the services at the same time, fewer resources would be required overall. PAF estimates that off-site staffing pools would require 30 percent fewer personnel than are currently needed to perform off-site functions.

Using Other Personnel to Fill Rated Officer Positions

Not all positions need to be filled by rated officers (e.g., pilots, navigators, and others cleared for aerial and space missions, who must rotate assignments frequently). Alternative staffing, including using DoD civilians, enlisted personnel, and contractors, offers the possibility of a more-experienced, stable workforce requiring less training time. PAF estimates

A global approach to command and control would be able to shift resources quickly from one region to another, while retaining the specific capabilities the COCOMs need within their areas of responsibility.

From left to right: John Drew, Dahlia Lichter, William Williams, Laura Baldwin, Kristin Lynch, Robert Tripp

Researcher Profile

PAF's analysis of AOC force-posture alternatives is the latest in a series of projects led by RAND senior management scientist Robert Tripp. For the past decade, Tripp and his team of researchers have been finding ways to improve the tools, concepts, and processes that enable rapid deployment and sustainment of air and space expeditionary forces. Under the umbrella of "agile combat support," their work has led to innovations in the way the Air Force conducts airlift, prepositions war reserve materiel, configures intermediate maintenance facilities, and commands and controls combat support activities and resources.

At the center of this work is a group of researchers who have been working together on logistics matters for many years. "Having a consistent team has made a big difference in what we can do for the Air Force," says Tripp. The group draws on both analytic expertise and operational knowledge gained from careers in the Air Force. Tripp himself served in the Air Force in a variety of logistics and research and development areas before retiring as a colonel. Project associate John Drew brings nearly 30 years of Air Force experience in aircraft maintenance and other logistics fields. Defense research analyst William "Skip" Williams has a varied background that includes more than 20 years of work for the Air Force and the Central Intelligence Agency. Adding to this operational experience, statistician and quantitative analyst Kristin Lynch provides mathematical and system-analysis skills that are central to the team's modeling efforts. These researchers form the core group that brought years of experience on previous PAF combat support studies to the AOC project.

Having a complementary mixture of backgrounds is only one of the group's strengths. "Working together

for so long, we've had opportunities to develop and refine our thinking and methods," says Tripp. He and his colleagues have invented many of the research methods and models that make agile combat support possible, and they have been able to refine and apply these tools to a variety of tasks. The global approach used in the AOC project is partly based on insights the team gained from several years of research into the sharing of combat support resources and intermediate maintenance facilities, first at the regional level and then worldwide.

"By investing in PAF's work on agile combat support and logistics, the Air Force had already built up the capability for us to do the AOC analysis," Tripp says. This capability goes beyond analytic expertise and includes the relationships that have developed between Tripp's team and the Air Force leaders and personnel who sponsor, guide, and use their research. These relationships were especially important during the data-collection phase of the AOC project, when the researchers needed to gather perspectives from both senior leaders and operators in the field. "People knew who we were, and they knew we were working in their best interests, even if that meant potentially changing the way things are done now," says Tripp.

Since briefing their findings to the Command and Control General Office Steering Group in May 2007, Tripp and his colleagues have been expanding their AOC analysis to include Air Force forces staff. "Our partnership with the Air Force is continually evolving to meet new challenges," says Tripp. "That's also true of our work as a research team. I'm proud of everyone involved and their ability to work together to make our nation's military more effective and efficient."

that this move would reduce staffing requirements by an additional 16 percent where these substitutions can take place.

Reducing Overhead and Redundancy

Reducing the AOC support overhead and decreasing redundant capabilities could enhance operational efficiencies. Of the Air Force's 38 AOC entities, approximately two-thirds could be characterized as providing support, some with underused facilities, overlapping authorities, and parallel capabilities. PAF recommended reassigning the AOC operational T&E workload to one or more operational AOCs under the leadership of the Air Combat Command. Likewise, the advanced training responsibilities of the AOC at Nellis AFB, Nevada, could be consolidated with one of the operational AOCs. These and other AOC support consolidations can help reduce manpower and resource needs without detracting from critical support requirements.

PAF's Analysis Provides a Vision for Global AOC Capability

These options can significantly reduce AOC crew requirements at moderate risk and can help the Air Force move toward distributed operations that offer greater flexibility in a dynamic world. A global approach to command and control would be able to shift resources quickly from one region to another, while retaining the specific capabilities the COCOMs need within their areas of responsibility.

Opposite: Controllers in the Combined Air Operations Center at an air base on the Arabian Peninsula monitor the status of ongoing missions supporting Operation Iraqi Freedom. This was the nerve center for all U.S. Central Command air operations when the first air strike occurred on March 20, 2003.

Below: Members of the personnel recovery coordination cell discuss a downed pilot recovery mission during Exercise Valiant Shield in the Air and Space Operations Center at Hickam Air Force Base, Hawaii.

While work in this area is ongoing, the Air Force has already begun to take steps toward realizing these benefits. After the PAF team briefed its recommendations to the Command and Control General Officer Steering Group in May 2007, the Air Force used the findings to support its latest AOC crew manning plans as part of its future programming and budget proposal. The findings and analytic approaches developed in the PAF study will continue to provide a basis for shaping the Air Force's vision of operational command and control in the future.

Why the Iraqi Resistance Was

Lessons for the United States and Its Potential Adversaries

So Weak

In the major combat phase of Operation Iraqi Freedom (OIF), conducted in March and April 2003, Coalition forces were able to displace Saddam Hussein's regime in less than three weeks. By the time the U.S. military entered Baghdad, the Iraqi Army had largely dissolved, but formal surrenders were comparatively few. Out of a total enemy force of some 350,000, only about 7,000 were taken prisoner—a small fraction of the more than 85,000 Iraqis captured in the 1991 Gulf War. Not a single organized Iraqi military unit remained intact when major combat ended. All the Iraqis who had survived the war, including those in units that had no contact with Coalition ground forces, had simply gone home.

To understand the reasons for this Iraqi military failure, PAF researcher Stephen Hosmer analyzed detailed information derived from interviews with former senior Iraqi civilian and military officials to answer two key questions: Why did the vast majority of Iraqi forces fail to offer significant or effective resistance? Why did the Iraqi leaders fail to adopt certain defensive measures that would have made the Coalition invasion more difficult and costly? Hosmer also discussed why U.S. leaders should be cautious about the lessons they draw from OIF, how OIF set the stage for the insurgency that followed, and how it may influence the calculations and behavior of future U.S. adversaries.

Saddam Hussein Made Strategic Miscalculations and Was Preoccupied with Internal Threats

Saddam Hussein believed that war with the United States could be avoided. However, he believed that if war occurred, the United States would not invade Iraq but would confine its operations to limited air attacks. In the unlikely event of an invasion, the Iraqi resistance would be sufficient to cause the United States and its Coalition allies to accept a negotiated political settlement that would leave his regime intact. The erroneous assumptions underlying Saddam's decisions went unchallenged because the loyalists who surrounded him, fearful of telling him what he did not want to hear, routinely misled him about the readiness and fighting will of his forces.

A statue of Saddam Hussein remains standing next to the antiaircraft headquarters destroyed by a U.S. attack on Baghdad.

Moreover, Saddam Hussein trusted neither the Iraqi military nor the populace as far as his own personal security or that of his regime was concerned. He moved frequently. He filled key defense positions and battlefield commands with members of his family and his Tikriti clan, even though these individuals were often only marginally qualified. He established multiple and competing military and militia organizations. He strictly controlled movement of all troops and equipment in the country, and he forbade the deployment of regular army or Republican Guard units inside Baghdad. These and other measures aimed at forestalling coups and rebellions degraded the quality of the military leadership and battlefield decisionmaking. They also prevented the coordination and unified command of troops charged with resisting the Coalition advance.

Iraq's Military Strategy and Operation Were Poorly Designed and Executed, and Iraqi Forces Were Not Motivated to Fight

Saddam's decision to have Republican Guard and regular army divisions defend Baghdad from distant external locations made these divisions extremely vulnerable to piecemeal destruction by U.S. air and ground

Steve Hosmer

During his 46 years at RAND, Steve Hosmer has conducted research on counterinsurgency warfare, foreign interventions in conflicts, the Vietnam War, the psychological dimensions of military operations, attempts to remove enemy leaders, the conflict over Kosovo, and Iraqi battlefield behavior in operations Desert Storm and Iraqi Freedom. The approach he has developed centers on a "multiperception analysis of war," which seeks an understanding of the course of warfare—the motivations, calculations, behaviors, and policies—from the standpoint of both the United States and its adversaries. As he points out, "Most postmortems focus on what the United States did. What I found so interesting is that the enemy's perceptions are quite different from ours. This leads to misapprehension of what they might do, and it affects the efficacy of our efforts." Steve's research on U.S. and Soviet behavior in Third World conflicts exemplified this approach. One study examined the principal constraints that shaped U.S. strategy; the companion report analyzed Soviet policy and practice toward such conflicts.

His research on the Vietnam War included a book based on captured enemy documents. In it, he examined the ways that the Viet Cong used terror and other forms of repression to intimidate local populations and undermine enemies in government. He notes that, "today, the widespread uses of assassination and intimidation by Iraqi insurgents mirror the scale and purpose of similar activities in Vietnam."

Steve's work on psychological and information warfare, much of which is documented in *Psychological Effects of U.S. Air Operations in Four Wars, 1941–1991*, addresses lessons for U.S. commanders. He observes that, "When most people think about psychological warfare, they focus on radio broadcasts and leaflets and what the content of those broadcasts and leaflets should be. Far more important are the psychological effects stemming from the military operations, which

forces. The immediate defense of the city was left largely to politically reliable but lightly armed militias and to Special Republican Guard units. However, no fixed defenses or barricades that could have provided strong fighting positions for these forces were erected. The Iraqi defensive plan did not incorporate measures that could have slowed the U.S. advance toward Baghdad, such as mining roads, destroying bridges, breaching dams, and even setting oil fields afire. Iraqi forces were further disadvantaged throughout the conflict by the fact that much of their armor and other military equipment was old and markedly inferior to that of the Coalition.

The lack of fighting will and the high desertion rate were attributable to the harsh service conditions (e.g., bad food, low pay, the need to bribe officers for home leave) that had depressed morale in Iraqi ranks even before the outbreak of hostilities. Furthermore, Iraqi officers and enlisted personnel alike were generally convinced that resistance against technologically superior U.S. forces would be pointless, and they saw little, if any, reason to fight and die for Saddam and his regime. The threat of eventual punishment that had previously deterred would-be deserters was no longer credible once it appeared that Saddam would be overthrown.

The Coalition's domination of the battlefield in OIF was also due to its capability to deploy well-equipped and highly trained and motivated fighting forces.

constitute the most powerful instruments for undermining an enemy's will to resist."

The fear of strategic air attacks played a key role in persuading the former Serbian leader, Slobodan Milosevic, to end the war over Kosovo. "Milosevic agreed to accept NATO's terms in large part because he erroneously believed that NATO would unleash a massive bombing of Serbia if he refused," Steve notes. "Here was an instance where an enemy misperception of our intentions worked very much to our advantage."

Similarly, in the 1991 and 2003 Persian Gulf wars, air power severely undermined Iraqi troop morale. In Operation Iraqi Freedom, for example, the Republican Guard's most effective fighting unit, the Al Nida Armored Division, disintegrated totally as a result of precision air strikes. "The Al Nida troops concluded they would be destroyed if they remained in their positions, so they abandoned their tanks and deserted home. Dying for Saddam Hussein was not on their agenda."

One of Steve's first projects at RAND was to organize and chair a symposium on counterinsurgency. The participants were a distinguished group of U.S. and allied officers who had a proven record of success in certain aspects of guerilla or counterinsurgency warfare. Although the symposium was held in 1962, U.S. military planners continue to draw on its insights, and the proceedings, titled *Counterinsurgency: A Symposium, April 16–20, 1962*, have recently been republished as a RAND Classic.

From his four decades of studying counterinsurgency in many forms, Steve has derived a set of counterinsurgency best practices. "The first and most important one," he says, "is to understand from the get-go that the war is going to have to be fought and won by the indigenous forces, not by U.S. forces, and that our role is to build up the capacity of host-nation forces to fight the war. We were slow to do this in Vietnam. Vietnamization came only after we had been bloodied, and public opinion was turning against our involvement. In the same way, we've been slow to devote adequate attention and resources to building the large and capable indigenous military forces that will be needed to bring stability to Iraq and Afghanistan. Of the hundreds of billions we've spent on security in Iraq, less than 6 percent of that money has gone to Iraqi police and military forces."

Steve's analytic accomplishments are broadly acknowledged and appreciated, but he has also received recognition for the many years he has devoted to help build the Friends of the National Zoo (FONZ), the nonprofit organization that supports the Washington, D.C., zoo's visitor-service, education, research, and conservation programs. Steve joined the FONZ board in 1972 at a time when it had 600 members and $3,000 in the bank. He later served as its treasurer and president, and he remains on its executive advisory committee. Today, the FONZ has over 40,000 dues-paying members and an annual operating revenue of nearly $20 million. In 2001, Steve received the Smithsonian Institution National Zoological Park Conservation Leadership Award for his outstanding contributions to the zoo's giant panda program.

A portrait of Saddam Hussein sits amid the wreckage of a destroyed presidential palace in Salman Pak, a Baghdad suburb where training facilities for the Republican Guard and Iraq's Fedayeen were located.

The physical and psychological effects of U.S. air attacks also had a major influence on Iraqi battlefield behavior. Former Iraqi commanders testified that U.S. bombing prompted massive numbers of their troops to abandon their equipment, desert, and return home. The entry of U.S. forces into Baghdad was a profound psychological shock to Iraqi military and civilian leaders in the capital, and it quickly undermined any remaining will to resist. When Saddam Hussein abandoned Baghdad on April 10, 2003, there were no longer any forces in the city for him to command.

Superior Military Capabilities Gave Coalition Forces an Overwhelming Advantage

The Coalition's domination of the battlefield in OIF was also due to its capability to deploy well-equipped and highly trained and motivated fighting forces. The discrepancy in capabilities was particularly telling in the relative immunity of Coalition armor to enemy fire and in the ability of Coalition ground and air forces to deliver accurate, lethal fire on Iraqi targets and to track them at standoff ranges. Finally, the Coalition's ability to maneuver ground forces rapidly and sustain them over long distances also undermined the Iraqi ability to mount a coherent defense.

OIF Paved the Way for the Insurgency That Followed

Several Iraqi actions before and during major combat operations in OIF helped facilitate and shape the insurgency that followed. Among them were the large-scale arming of Ba'athist and other Saddam loyalists, the widespread dispersal of munitions and weapon stockpiles, the release of criminals from Iraqi prisons, and the movement into Iraq of thousands

of highly motivated foreign jihadists. As the Iraqi defenses collapsed, massive desertions released into the countryside personnel who possessed the skills, resources, and potential motivation to mount and sustain a resistance against the Coalition. Their flight also deprived the Coalition of the indigenous military and security forces and civilian officials that Coalition planners had counted on to help stabilize and secure Iraq. This opened the way for widespread looting and lawlessness that made reconstruction more difficult and costly and undermined public support for the occupation.

What Lessons Can the United States and Its Potential Adversaries Draw from OIF?

Given the weakness of the Iraqi resistance to the Coalition invasion, it is important to recognize what OIF does *not* teach. For example, it would be unwarranted to conclude that high-tech weaponry and communications will inevitably enable smaller U.S. forces to be decisive against larger but less technologically capable enemy forces in future conflicts or that invasions can be conducted at minimal cost in U.S. casualties in the absence of extended preparatory air attacks.

Similarly, U.S. decisionmakers should recognize that potential adversaries are likely to derive their own lessons from OIF and may respond by pursuing strategies and capabilities that would aim to deter U.S. intervention and neutralize our conventional military advantages. For example, it is possible that OIF could act as an additional spur for such states as Iran and Korea to acquire and retain nuclear weapons. Potential adversaries are also likely to calculate that they cannot effectively fight U.S. ground forces as long as U.S. air forces can gain and exploit air supremacy. Thus, they may seek to upgrade their air defenses and improve their ability to deny U.S. aircraft the use of proximate air bases.

Possessing a well-developed capability to wage insurgent and urban warfare could also become an attractive option. Enemy leaders might conclude that the prospect of becoming bogged down in a protracted guerilla conflict could act as a deterrent to the United States or, if deterrence failed, could eventually impose sufficient costs to force a withdrawal or lead to a politically acceptable settlement.

Whenever U.S. ground forces become engaged with hostile elements in future conflicts, they must anticipate the possibility of a guerilla-type response. In such contingencies, the United States will need forces that are organized, trained, equipped, and culturally sensitized for counterinsurgency warfare.
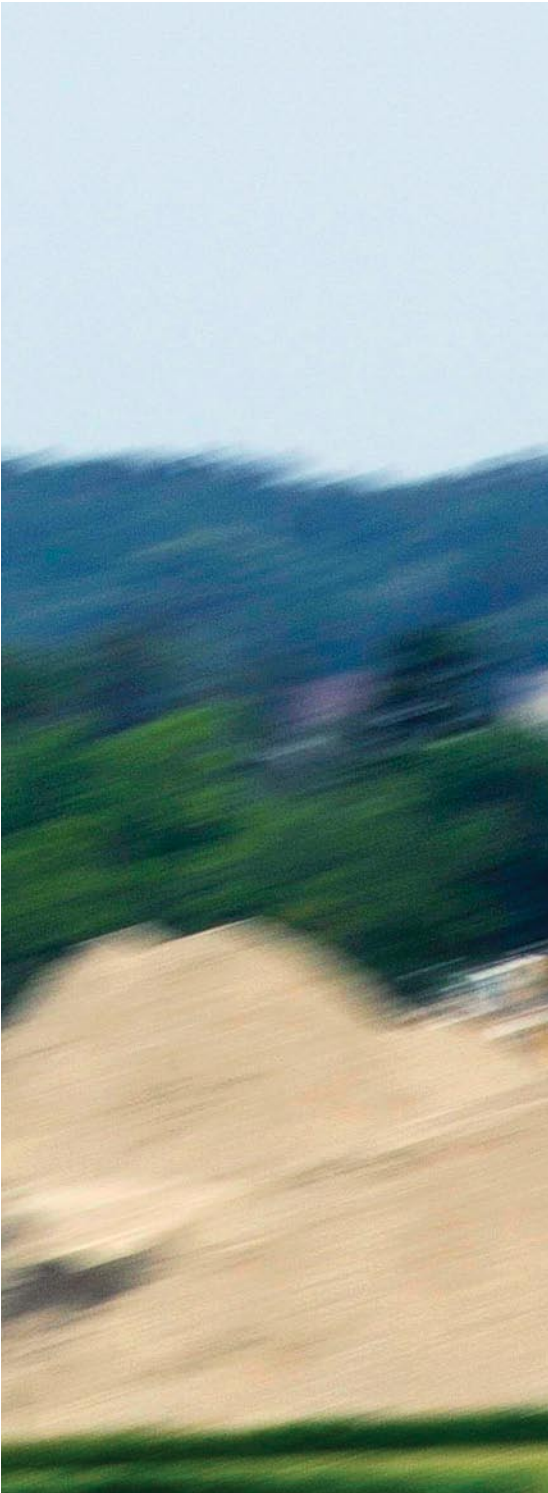
WHY THE IRAQI RESISTANCE TO THE COALITION INVASION WAS SO WEAK

STEPHEN T. HOSMER

PROJECT AIR FORCE
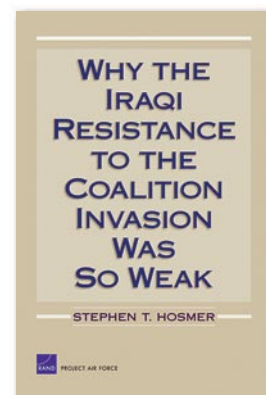
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MG-544-AF, *Why the Iraqi Resistance to the Coalition Invasion Was So Weak*, by Stephen T. Hosmer. Online at http://www.rand.org/pubs/monographs/MG544/

Test and Evaluation Facilities

Is the Air Force Overinvested?

and Capabilities

As the Air Force has found itself reflecting on its history, it has also been contemplating where it is going and what it needs to do now to get there. That future encompasses not only the responsibilities in the air that gave birth to the service 60 years ago and those in space that are so critical today but also, increasingly, those in the cyber domain.

Yet, as the service contemplates institutional changes to accommodate shifting demands, it must also keep in mind that resources are limited. Contending with growing financial pressures means setting priorities and making decisions that are not necessarily comfortable.

Consolidation Is Never Comfortable

This is what happened in 2006. DoD had to find the resources for urgent recapitalization projects and asked for the services' cooperation. Within the Air Force, the Air Force Materiel Command (AFMC) thought it could help, to the tune of nearly $400 million of its budget, by streamlining some of its test and evaluation (T&E) facilities and capabilities.

The required consolidation would most directly affect Eglin AFB, Florida, with its 46th Test Wing moving and being consolidated with the 412th Test Wing at Edwards AFB, California. This would limit the amount of testing that could be done at Eglin. In addition, AFMC's plan would affect a number of test facilities at Eglin and at other locations.

It is perhaps not surprising that this would raise concerns among those who lived and worked on or near Eglin and, through them, their representatives. However, it soon became apparent that the move would have consequences for a broader set of interested parties. It also became clear that a second look was indeed in order. In late 2006, Congress called for further study of the AFMC proposal, and the Air Force asked PAF to perform the analysis.

Getting a Complete Picture Required Taking a Multidisciplinary Approach

To gather the data for its analysis, the PAF team was able to count on PAF's ongoing partnership with the Air Force, which made it possible to gather financial data from test facilities, test-center staff, and customers with which to calculate the economic costs and benefits of the proposal.

Maj. Paul "Max" Moga, the first F-22A Raptor Demonstration Team pilot, does a "max climb" seconds after takeoff.

Researcher Profile

The prospect of realigning military resources can provoke a fair amount of apprehension for the people and organizations that use, operate, and support the facilities in question. When RAND senior policy researcher Mike Thirtle took on the task of evaluating AFMC's proposal to streamline Air Force T&E facilities, he knew that success depended on his project being—and being perceived as—objective, comprehensive, and transparent to the many stakeholders who would be affected by the plan.

The first step was to assemble a research team that included experienced people who understood the operational realities but also had the analytic skills needed to step back and assess the costs, benefits, and potential drawbacks of the proposed changes for the entire system. Thirtle is a graduate of the Air Force Academy and the Frederick S. Pardee RAND Graduate School for public policy and has served as an officer in both the Air Force and the Air Force Reserve. Joining him was a group of senior RAND researchers, including mathematician and former Director of PAF Natalie Crawford, cost analysts Bernie Fox and Ian Cook, physical scientist Tom Hamilton, engineers Jeff Hagen and David Vaughan, Air Force Fellow Michelle Grace, behavioral scientist Larry Hanser, and information scientist Herb Shukiar. The Air Force knew these individuals and trusted them to provide a scientifically rigorous evaluation.

The next step was to make sure that the analysis was comprehensive enough to address the concerns of all those likely to be affected by the proposed changes. In addition to gathering cost data, Thirtle and his team looked at personnel issues, operations on other bases, and the overall T&E mission. They took Army and Navy perspectives into account, because changes in the T&E infrastructure would likely affect the other services, which either use Air Force facilities or would need to handle additional demands themselves as a result of consolidation. The team interviewed more than 200 people in all. This broad approach was essential to identifying such issues as the effect of reducing open-air range capacity on ground-based testing and reassuring all the stakeholders that the changes could be made in a way that was responsive to their concerns.

Finally, the complexity and sensitivity of the T&E plan called for a greater-than-usual amount of communication between Thirtle's group and the many organizations involved. Throughout the project, the team gave more than 20 interim and final briefings to the Air Force Chief of Staff; other general officers at the Pentagon and multiple bases; and senators, congressmen, and their staffs. Thirtle especially stayed in touch with congressional staffs from the affected districts to make sure that the analysis was addressing their concerns. His team also worked closely with such organizations as DoD's Test Resource Management Center to gather and reconcile data from groups that were not accustomed to working with each other, let alone keeping track of information in the same ways.

By the end of the process—which spanned only four months, from November 2006 to March 2007—organizations were talking, sharing common data, and preparing to move forward together. PAF's analysis concluded that such cooperation was precisely what was needed to make the T&E plan work. Thirtle and his colleagues plan to build on this momentum as they continue to assist efforts to streamline the Air Force T&E infrastructure.

From left to right: David Vaughan, Ian Cook, Natalie Crawford, Mike Thirtle, Thomas Hamilton, Lawrence Hanser, Herb Shukiar, Jeff Hagen. Not pictured: Michelle Grace and Bernie Fox.

Of course, the true cost of moving is never as simple as summing the bills of realtors and movers. In this instance, it was important to account not only for the financial aspects—the costs and savings—related to one particular unit but also for the financial and other effects on other units and personnel. So, for example, the team needed to address personnel issues, operations on other bases, and the overall T&E mission and thus collected data on the functions and uses of facilities and ranges, maintenance activities, flying hours, and other important information.

One specific concern, however, was how the consolidation might directly affect the Army and Navy. Both services either use Air Force test ranges themselves or would need to handle additional demands for their own test facilities. Closing a test center does not mean that the need for testing disappears.

Some, but Not All, Proposed Changes Have Merit

In general, RAND found that the consolidation of the two test wings could yield substantial cost savings. Much of the savings would accrue from reductions in personnel (and, possibly, aircraft) that a consolidation would permit. There are, however, additional consequences that need to be factored in for the move to be practicable.

The 46th Test Wing and the 53rd Wing currently share a maintenance function, which would have to be sorted out so that neither wing suffers.

The consolidation would mean both reducing the amount of open-air (flying) aircraft testing that can be done at Eglin AFB and increasing the amount that must be done at Edwards AFB. That workload could, given considerable coordination between the Air Force and the

A crew chief with the 1st Fighter Wing from Langley Air Force Base, Virginia, directs an F-22 Raptor as it taxis down the runway.

Navy, be shared with the Navy installations at Point Mugu and China Lake, California. In any case, the move could affect myriad other users as well.

Facility closures are also a complicated matter. Several of the facilities that AFMC had proposed for closure offer unique capabilities, and replacing them would be unrealistic. Other facilities are not necessary to the Air Force but could be transferred to other operators, perhaps other services.

Some Eglin facilities that support open-air testing also conduct ground-based activities, such as testing munitions and security systems. Simply closing them because they are no longer used for open-air testing would have financial consequences for DoD customers. PAF identified eight facilities that the Air Force should either keep open or consider transferring to other services.

The Air Force and DoD Should Take a Broad, Strategic Look at T&E

A key message of this work was that implementing the AFMC proposal involves a fair amount of risk. Schedule delays for program testing, increased customer costs, and decreased T&E capacity are all possible. PAF recommended that the Air Force gather more information so that it can minimize these risks and increase its understanding of how the realignment plan would affect customers, test organizations, and DoD.

The Air Force and DoD have since taken steps in this direction. A follow-on PAF study is examining Air Force T&E from a broad, strategic perspective and is expected to offer solid recommendations for how the Air Force can make its overall T&E enterprise more effective and efficient. The Office of the Secretary of Defense is also conducting a study that will contribute to Air Force decisionmaking on T&E issues. Both studies will be completed in the near future. Along with PAF's cost-benefit analysis, these studies will enable the Air Force to proceed with cost-saving measures without sacrificing the high-quality T&E functions that are essential to modernizing U.S. military capabilities.

A key message of this work was that implementing the AFMC proposal involves a fair amount of risk.

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